

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
13 January 2005 (13.01.2005)

PCT

(10) International Publication Number
WO 2005/003646 A1

(51) International Patent Classification⁷: F24J 2/36,
2/52, 2/54

(21) International Application Number:
PCT/AU2004/000883

(22) International Filing Date: 1 July 2004 (01.07.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2003903335 1 July 2003 (01.07.2003) AU

(71) Applicant (for all designated States except US): **SOLAR HEAT AND POWER PTY LTD** [AU/AU]; Level 25, Chifley Tower, 2 Chifley Square, Sydney, New South Wales 2000 (AU).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **LE LIEVRE, Peter** [AU/AU]; 2A Toongarrah Road, North Sydney, New South Wales 2060 (AU).

(74) Agent: **GRIFFITH HACK**; GPO Box 4164, Sydney, New South Wales 2001 (AU).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

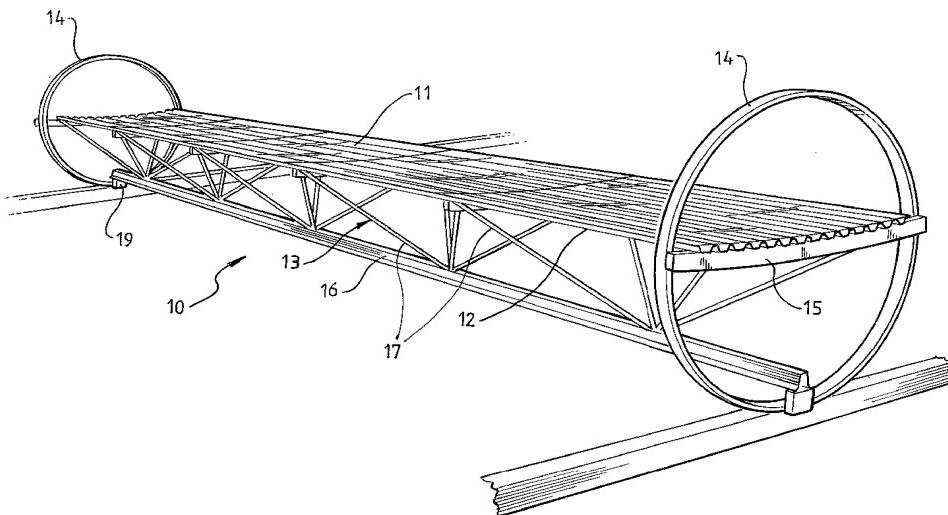
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: CARRIER AND DRIVE ARRANGEMENT FOR A SOLAR ENERGY REFLECTOR SYSTEM



(57) Abstract: A carrier and drive arrangement is disclosed for use in a solar energy reflector system. The arrangement comprises a) a carrier structure (10) having a platform (12) for supporting a reflector element (11), a frame portion (13) that includes hoop-like end members (14) between which the platform extends and support members (18) which support the frame portion by which of the end members and which accommodate turning of the carrier structure about an axis of rotation that is substantially coincident with a longitudinal axis of the reflector element, and b) a drive system incorporating an electric motor for imparting unidirectional turning drive to the carrier structure by way of the hoop-like end members (14).

WO 2005/003646 A1

- 1 -

CARRIER AND DRIVE ARRANGEMENT FOR A SOLAR ENERGY REFLECTOR SYSTEM

FIELD OF THE INVENTION

- 5 This invention relates to a carrier and drive arrangement for a solar energy reflector system of a type that is employed for reflecting incident radiation to a solar energy collector system.

BACKGROUND OF THE INVENTION

- 10 Various solar energy reflector-collector systems have been developed for use in harnessing solar radiation that falls incident over areas that might range in size from 5×10^1 m² to 25×10^6 m². In this context reference is made to collector systems that have been disclosed in Australian Patents 694335 and 724486 dated 28 March 1996 and 15 December 1997 respectively.

The most relevant of the earlier known reflector-collector systems, including those disclosed in the referenced patents, employ a field of reflectors which are driven to track movement of the sun (relative to the earth) and which are orientated to reflect incident radiation to distant, elevated collector systems. In the case of the system that is disclosed in Patent number 694335, at least some of the reflectors are mounted and arranged to be driven in a manner such that their orientation may be changed to move the direction of reflected radiation from one collector system to another.

The present invention has been developed from a perceived need for a carrier that is suitable for supporting a reflector element in a reflector system and which also provides for convenient transmission of sun-tracking drive from an electric drive motor.

SUMMARY OF THE INVENTION

Broadly defined, the present invention provides a carrier and drive arrangement for use in a solar energy reflector system and which comprises:

- 35 a) a carrier structure having-
i) a platform for supporting a reflector element,

- 2 -

- ii) a frame portion that includes hoop-like end members between which the platform extends and
 - iii) support members which support the frame portion by way of the end members and which accommodate turning of the carrier structure
- 5 about an axis of rotation that is substantially coincident with a longitudinal axis of the reflector element when supported by the platform; and
- b) a drive system incorporating an electric motor for imparting turning drive to the carrier structure by way of at least one of the end members.

10

OPTIONAL FEATURES OF THE INVENTION

- The carrier structure may, in one embodiment of the invention, be carried by the support members in a manner which accommodates unidirectional rotation of the carrier structure about the axis of rotation
- 15 that is substantially coincident with the longitudinal axis of the reflector element. By "substantially coincident" is meant that the axis of rotation is located coincident with or adjacent to the longitudinal axis of the reflector element.
- 20 The drive system incorporating the electric motor may, in accordance with one embodiment of the invention, be arranged to impart unidirectional turning drive to the carrier structure. By providing such unidirectional drive, the traditional requirement for a reversible motor or a pivoting mechanism, with attendant backlash and other problems,
- 25 is avoided. Also, by employing such a drive system, the carrier structure may be parked in a selected angular position with the reflector element orientated downwardly, to shield it from adverse ambient conditions, during the process of turning (ie, rotating) the carrier structure through 360 degrees during each 24-hour period. Furthermore, the carrier
- 30 structure may at any time within each 24-hour period be rotated temporarily to a selected angular position with the reflector element orientated in a direction away from potentially damaging climatic conditions.
- 35 Also, the drive system may, in one embodiment of the invention, be arranged to impart the unidirectional drive to the carrier structure by

way of one only of the end members of the frame portion of the carrier structure.

5 The platform for the reflector element may, in one embodiment of the invention, comprise a fluted or corrugated metal panel, with the flutes or corrugations forming the stiffening elements of the platform. In such case, the reflector element will be supported upon the crests of the flutes or corrugations. Furthermore, although the flutes or corrugations may extend in a direction that intersects the longitudinal axis of the reflector element, the flutes or corrugations desirably are orientated to extend in a direction parallel to the longitudinal axis of the reflector element.

10 Also, although the platform may be formed with a flat surface or such that the crests of the flutes or corrugations are located in a flat plane, the platform desirably is curved concavely in a direction orthogonal to the longitudinal axis of the reflector element.

15 The frame structure of the carrier structure may comprise a skeletal frame structure having the hoop-like end members that extend about the axis of rotation of the carrier structure and between which the platform extends.

20 The support members which support the carrier structure by way of the hoop-like end members, may comprise spaced-apart supporting rollers. Such rollers desirably are sized and otherwise arranged to track within a channel region of the associated end members.

25 The drive system for imparting drive to the carrier structure may, in accordance with one embodiment of the invention, be coupled to at least one of the hoop-like end members and it desirably incorporates a link chain that extends around and is fixed to one of the end members to form, in effect, a gear wheel. In the latter case a sprocket will be provided to engage with the link chain and to impart drive to the end member from the electric motor. With such a drive arrangement, a relatively inexpensive electric motor may be employed and, with appropriately sized end members of the carrier structure, a high

- 4 -

reduction in drive velocity and a commensurate increase in torque transmission may be obtained.

- The reflector element may comprise a single panel-shaped glass mirror or a reflective metal panel, but it desirably comprises a plurality of square or rectangular glass mirrors that are mounted in edge abutting relationship upon the supporting platform. In this case the rear, silvered faces of the mirrors may be protected against adverse ambient conditions by sealing surrounding gaps and spaces with a silicone or other suitable sealant. When, as mentioned above, the platform for the reflector element is curved concavely, the reflector element will be secured to the platform in a manner such that the concavity will be transferred to the reflecting surface of the reflector element.
- 15 The carrier structure and drive system of the invention may be embodied in various arrangements, one of which is now described, by way of example, with reference to the accompanying drawings. The carrier structure and drive system is described in the context of a complete reflector system.
- 20

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings-

- Figure 1 shows a perspective view of the reflector system with a carrier structure of the system rotated to an angular position in which a reflector element is orientated to reflect in an upward direction,
- 25 Figure 2 shows a perspective view of the same reflector system but with the carrier structure rotated through approximately 180 degrees to expose the underside of a platform and skeletal frame structure for the reflector element,
- 30 Figure 3 shows, on an enlarged scale, a portion of an end member and a drive system of the reflector system, and
- Figure 4 shows, also on an enlarged scale, a portion of the end member and an associated mounting arrangement for the reflector system.

DETAILED DESCRIPTION OF AN EMBODIMENT OF THE INVENTION

As illustrated, the reflector system in its exemplified embodiment comprises a carrier structure 10 to which a reflector element 11 is

- 5 -

mounted. The carrier structure itself comprises an elongated panel-like platform 12 which is supported by a skeletal frame structure 13. The frame structure includes two hoop-like end members 14.

- 5 The members 14 are centred on and extend about an axis of rotation that is approximately coincident with a central, longitudinally-extending axis of the reflector element 11. The axis of rotation does not need to be exactly coincident with the longitudinal axis of the reflector element but the two axes desirably are at least adjacent on another.

1.0

In terms of overall dimensions of the reflector system, the platform 12 is approximately twelve metres long and the end members 14 are approximately two metres in diameter.

- 15 The platform 12 comprises a corrugated metal panel and the reflector element 11 is supported upon the crests of the corrugations. The corrugations extend parallel to the direction of the longitudinal axis of the reflector element 11, and the platform 12 is carried by six transverse frame members 15 of the skeletal frame structure 13. End 20 ones of the transverse frame members 15 effectively comprise diametral members of the hoop-like end members 14.

The transverse frame members 15 comprise rectangular hollow section steel members and each of them is formed with a curve so that, when 25 the platform 12 is secured to the frame members 15, the platform is caused to curve concavely (as viewed from above in Figure 1) in a direction orthogonal to the longitudinal axis of the reflector element 11. The same curvature is imparted to the reflector element 11 when it is secured to the platform 12.

30

The radius of curvature of the transverse frame members 15 is in the range of twenty to fifty metres and preferably of the order of thirty-eight metres.

- 35 The skeletal frame 13 of the carrier structure 10 also comprises a rectangular hollow section steel spine member 16 which interconnects the end members 14, and a space frame which is fabricated from

- 6 -

tubular steel struts 17 connects opposite end regions of each of the transverse frame members 15 to the spine member 16. This skeletal frame arrangement, together with the corrugated structure of the platform 12 provides the composite carrier structure 11 with a high degree of torsional stiffness.

The hoop-like end members 14 are formed from channel section steel, such that each end member is provided with a U-shaped circumferential portion and, as shown in Figure 4, each of the members 14 is supported for rotation on a mounting arrangement that comprises two spaced-apart rollers 18. The rollers 18 are positioned to track within the channel section of the respective end members 14, and the rollers 18 provide for turning (ie, rotation) of the carrier structure 10 about the axis of rotation that is approximately coincident with the longitudinal axis of the reflector element 11.

As also shown in Figure 4, a hold-down roller 18a is located adjacent the support rollers 18 and is positioned within the associated end member 14 to prevent lifting of the reflector system under adverse weather conditions.

A drive system, as shown in see Figure 3, is provided for imparting unidirectional drive to the carrier structure 10 and, hence, to the reflector element 11. The drive system comprises a shaded pole or other similar such non-reversible electric motor 19 having an output shaft coupled to a sprocket 20 by way of reduction gearing 21. The sprocket 20 meshes with a link chain 22 through which drive is directed to the carrier structure 10.

- 30 The link chain 22 extends around and is fixed to the periphery of the outer wall 23 of the channel-section of one of the end members 14. That is, the link chain 22 affixed to the end member effectively forms a type of gear wheel with which the sprocket 20 engages.
- 35 With the end member 14 having a diameter in the order of 2.00 m and the sprocket 20 having a pitch circle diameter of 0.05 m, reduction gearing and torque amplification in the order of (40.r):1 may be

- 7 -

obtained, where r is the reduction obtained through gearing at the output of the electric motor 19.

5 The reflector element 11 is formed by butting together five glass mirrors, each of which has the dimensions 1.8 m X 2.4 m. A silicone sealant is employed to seal gaps around and between the mirrors and to minimise the possibility for atmospheric damage to the rear silvered faces of the mirrors, and the mirrors are secured to the crests of the platform 12 by a urethane adhesive.

10

The mirrors have a thickness of 0.003 m and, thus, they may readily be curved in situ to match the curvature of the supporting platform 12.

15

Depending upon requirements, two or more of the above described reflector systems may be positioned linearly in a row and be connected one to another by way of adjacent ones of the hoop-like end members 14. In such an arrangement a single drive system may be employed for imparting unidirectional drive to the complete row of reflector systems.

20

Variations and modifications may be made in respect of the carrier structure as above described by way of example without departing from the scope of the appended claims.

THE CLAIMS

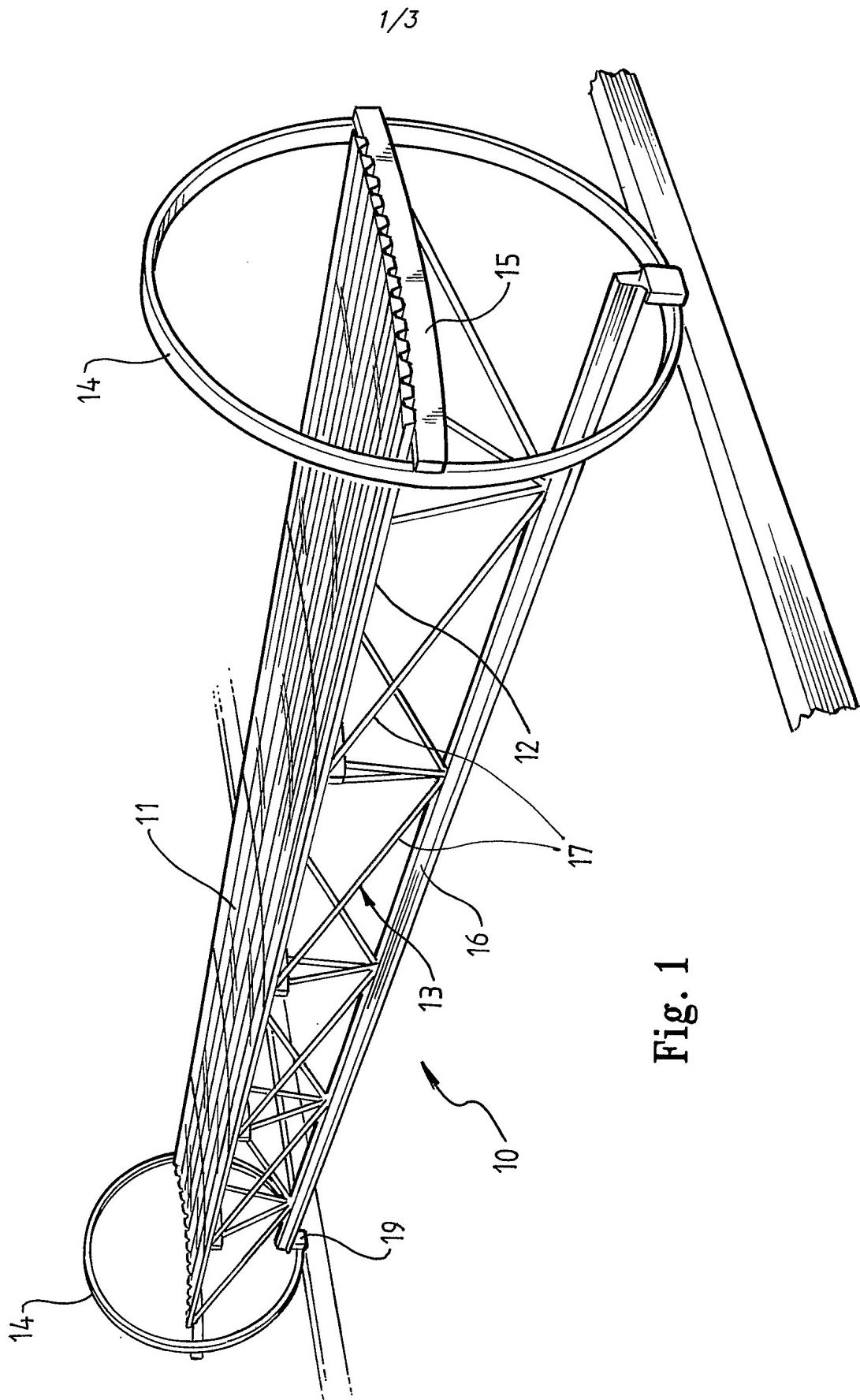
1. A carrier and drive arrangement for use in a solar energy reflector system and which comprises:
 - 5 a) a carrier structure having:
 - i) a platform for supporting a reflector element,
 - ii) a frame portion that includes hoop-like end members between which the platform extends and
 - iii) support members which support the frame portion by way of the end members and which accommodate turning of the carrier structure about an axis of rotation that is substantially coincident with a longitudinal axis of the reflector element when supported by the platform; and
 - b) a drive system incorporating an electric motor for imparting turning drive to the carrier structure.
2. The carrier and drive arrangement as claimed in claim 1 wherein the drive system is arranged to impart unidirectional turning drive to the carrier structure by way of one of the end members.
- 20 3. The carrier and drive arrangement as claimed in claim 2 wherein the drive system comprises:
 - a) a link chain that extends around and is fixed to the end member to form, in effect, a gear wheel and
 - 25 b) a sprocket for transferring drive from the electric motor to the link chain.
4. The carrier and drive arrangement as claimed in any one of claims 1 to 3 wherein the platform comprises a panel-like platform which is formed with stiffening elements in the form of corrugations and wherein the reflector element is supported upon the crests of the corrugations.
- 30 5. The carrier and drive arrangement as claimed in any one of claims 1 to 3 wherein the platform comprises a panel-like platform which is formed with stiffening elements in the form of flutes and wherein the reflector element is supported upon the crests of the flutes.

6. The carrier and drive arrangement as claimed in claim 4 or claim 5 wherein the stiffening elements are orientated to extend in a direction parallel to the longitudinal axis of the reflector element.
- 5
7. The carrier and drive arrangement as claimed in any one of the preceding claims wherein the platform is curved concavely in a direction orthogonal to the longitudinal axis of the reflector element.
- 10 8. The carrier and drive arrangement as claimed in claim 7 wherein the platform is curved with a radius of curvature within the range of 20 to 50 metres.
- 15 9. The carrier and drive arrangement as claimed in claim 7 or claim 8 wherein the reflector element is secured to the platform in a manner such that the curvature of the platform is imparted to the reflector element.
- 20 10. The carrier and drive arrangement as claimed in any one of the preceding claims wherein the reflector element comprises a panel-shaped glass mirror.
- 25 11. The carrier and drive arrangement as claimed in any one of claims 1 to 9 wherein the reflector element comprises a plurality of edge-abutting glass mirrors.
12. The carrier and drive arrangement as claimed in any one of claims 9 to 11 wherein the reflector element is adhered to the platform.
- 30 13. The carrier and drive arrangement as claimed in any one of claims 1 to 12 wherein each of the hoop-shaped end members has a channel-section circumferential portion and a diametrically extending member that is constituted by a transverse frame member of the platform.
- 35 14. The carrier and drive arrangement as claimed in claim 13 wherein the support members comprise spaced-apart supporting rollers

- 10 -

which track within the circumferential portion of associated ones of the end members.

15. A carrier and drive arrangement substantially as shown in the
5 accompanying drawings and substantially as hereinbefore described
with reference thereto.



2/3

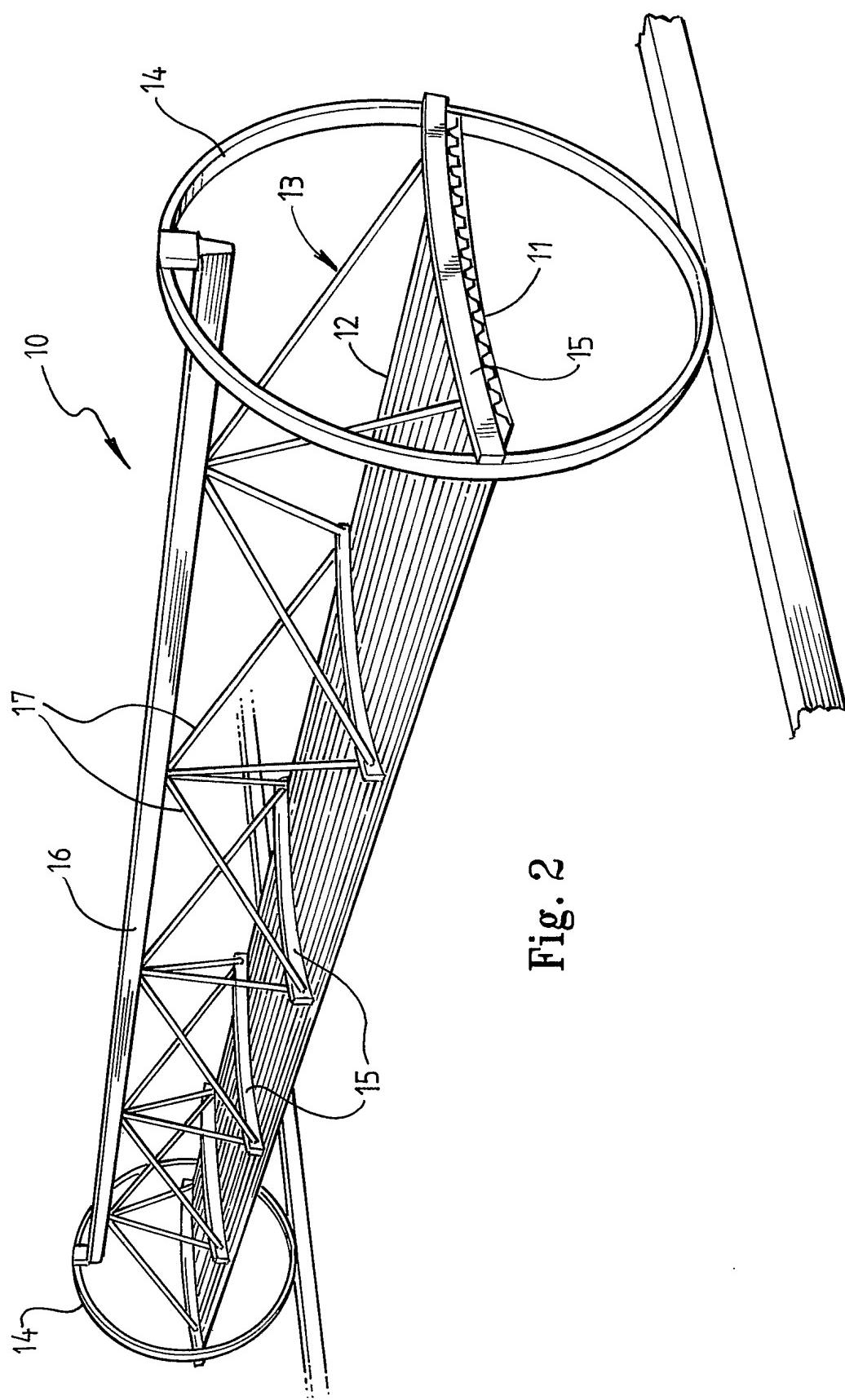


Fig. 2

3/3

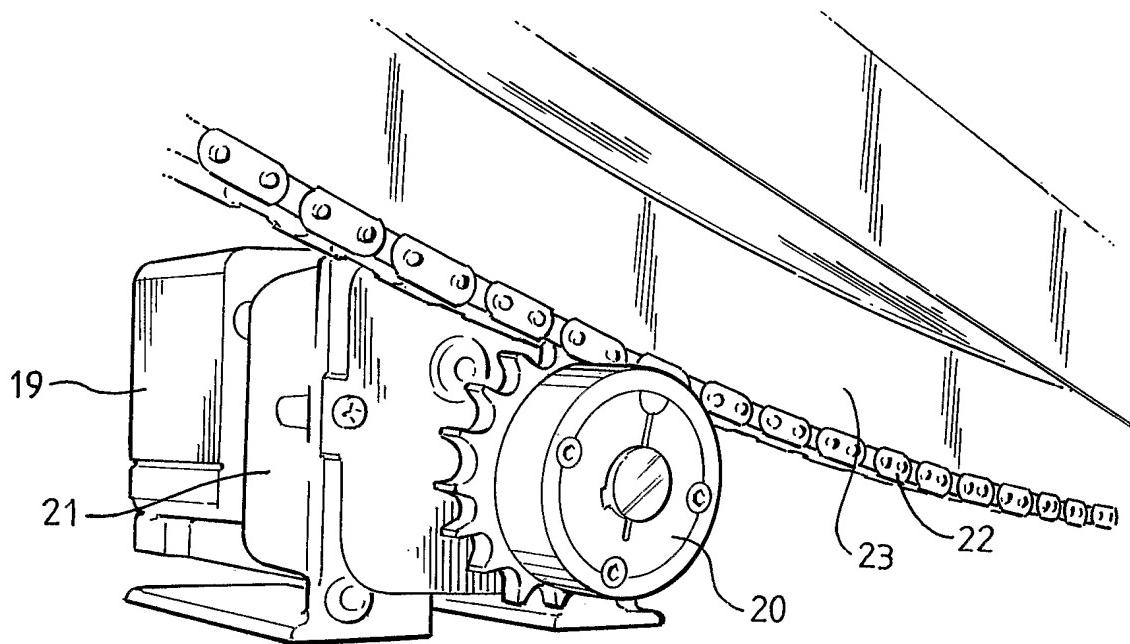


Fig. 3

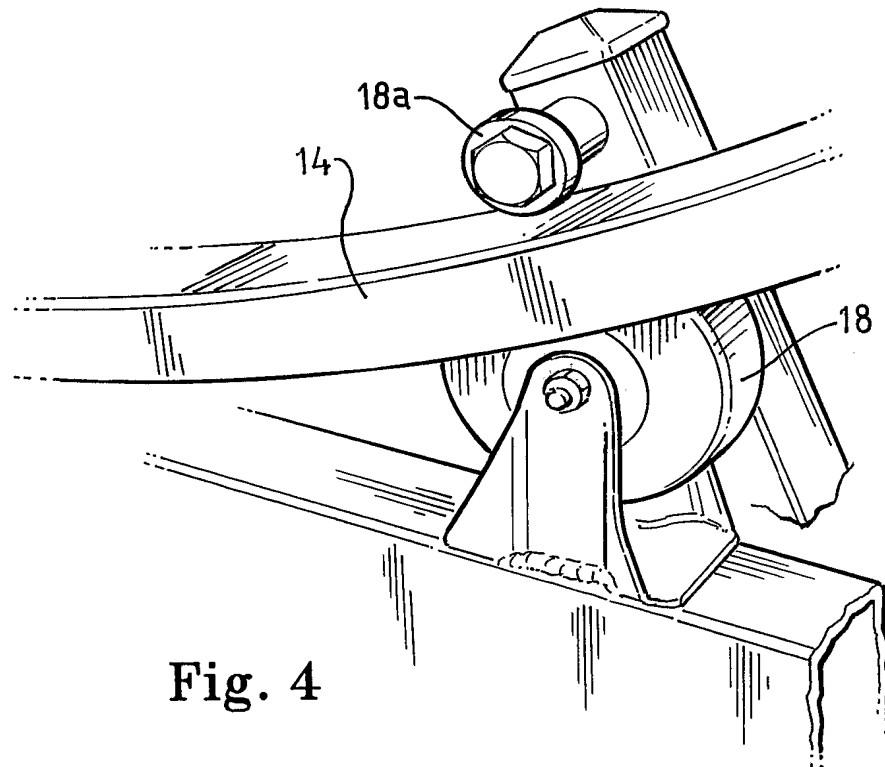


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2004/000883

A. CLASSIFICATION OF SUBJECT MATTER												
Int. Cl. ^{7:} F24J 002/36,002/52,002/54												
According to International Patent Classification (IPC) or to both national classification and IPC												
B. FIELDS SEARCHED												
Minimum documentation searched (classification system followed by classification symbols)												
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched												
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) DWPI IPC F24J 002/36,002/52,002/54 and keywords												
C. DOCUMENTS CONSIDERED TO BE RELEVANT												
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.										
X	US 4111184A (PERKINS) 5 September 1978 See whole document.	1-15										
X	US 4106485 A (POLLEY) 15 August 1978 See whole document	1-15										
X	US 787145 A (BROWN) 11 April 1905 See whole document	1-15										
<input type="checkbox"/> Further documents are listed in the continuation of Box C		<input checked="" type="checkbox"/> See patent family annex										
<p>* Special categories of cited documents:</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%; vertical-align: top;"> "A" document defining the general state of the art which is not considered to be of particular relevance </td> <td style="width: 30%; vertical-align: top;"> "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention </td> </tr> <tr> <td style="vertical-align: top;"> "E" earlier application or patent but published on or after the international filing date </td> <td style="vertical-align: top;"> "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone </td> </tr> <tr> <td style="vertical-align: top;"> "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) </td> <td style="vertical-align: top;"> "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art </td> </tr> <tr> <td style="vertical-align: top;"> "O" document referring to an oral disclosure, use, exhibition or other means </td> <td style="vertical-align: top;"> "&" document member of the same patent family </td> </tr> <tr> <td style="vertical-align: top;"> "P" document published prior to the international filing date but later than the priority date claimed </td> <td></td> </tr> </table>			"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family	"P" document published prior to the international filing date but later than the priority date claimed	
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention											
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone											
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art											
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family											
"P" document published prior to the international filing date but later than the priority date claimed												
Date of the actual completion of the international search 11 August 2004	Date of mailing of the international search report 31 AUG 2004											
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer G. CARTER Telephone No : (02) 6283 2154											

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2004/000883

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member
US	4111184	NIL
US	4106485	NIL
US	787145	NIL

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX